



MorphoDig

MorphoDig Tutorials

Tutorial 03: working with many surface objects.



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Tutorial 03 includes:

- A series of 74 .vtk surface files, each representing a bone belonging to *Canariomys bravoii*
- Two series of 74 .pos files (to orientate and position each bone)
- Two .ntw (project) files. The first one to open each bone in initial orientation/position. The second one to open each bone in anatomical orientation.
- One .ori (orientation helper labels) file
- The present .pdf document

Before using this tutorial, please download and read MorphoDig User Guide.

3.1 About the present reconstruction

3.1.1 About the specimens

The present three-dimensional reconstruction of the skeleton of the giant rat of Tenerife (Canary Islands, Spain) was obtained by computerized microtomography reconstruction. Two distinct specimens were used in this reconstruction, TFMCV872 and TFMCV873 (Museo de la Naturaleza y el Hombre, Santa Cruz). TFMCV872 is an almost complete but disarticulated skeleton of *C. bravoii*. As mandibles and skull of this specimen were not well preserved, a complete cranium of *C. bravoii* (TFMCFV873) was added to this reconstruction. The reconstruction

of this fossil was published by Michaux et al. [2012] and the 3D model was subsequently disseminated in MorphoMuseum [Michaux et al., 2015].

3.1.2 Completeness

Murinae rodents observed by Owen [1853] always possess a total amount of 19 thoraco-lumbar vertebrae, most often divided in 13 thoracic and 6 lumbar vertebrae (he also observed at least one specimen of *Rattus norvegicus* possessing 12 thoracic and 7 lumbar vertebrae). This number of 19 thoraco-lumbar vertebrae is observed very often in mammals and is thought to be a plesiomorphic condition for eutherians and metatherians mammals (for a review, see for instance Sánchez-Villagra et al., 2007). The present fossil of *C. bravoii* exhibits a number of 17 thoraco-lumbar vertebrae, so there is a high probability that 2 vertebrae (either 1 thoracic and 1 lumbar, or 2 lumbar) are missing. Furthermore, the number of caudal vertebrae in Murinae rodents observed by Owen [1853] is often greater than the 21 presented in this reconstruction. The present reconstruction of *Canariomys bravoii* does not take into account these potentially missing thoraco-lumbar and caudal vertebrae, and you may find it sensible to propose new reconstructions of this fossil based on your own observation or Murinae rodents.

3.2 Tutorial

Download and unzip the files associated to this tutorial.

3.2.1 Opening surfaces.

Download and unzip the 3D files associated to this tutorial. Open MorphoDig.

You may open the enclosed .vtk surface files (File -> Surface -> Open Surface) or one by one, but as there are 74 surfaces, this is time consuming. MorphoDig offers two faster alternatives:

- You may drag and drop all selected files at once in the 3D main window (see Fig. 3.1-A p.4).
- You may also open all selected files at once when clicking on the "open" (📁) button inside the main window (or press "CTRL +O").

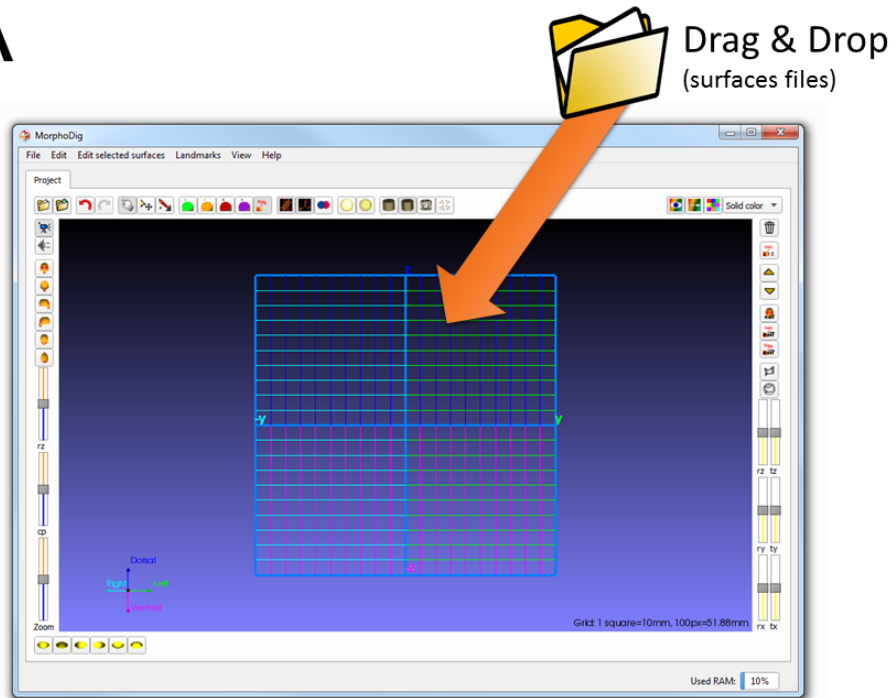
3.2.2 Setting the position of each bone.

You may interact with selected objects (those which are drawn grey) in different ways (see MorphoDig user guide for further explanations).

There are three ways to select one, several or all currently opened surfaces:

- **Selecting surfaces 1 by 1:** press "CTRL +D" to unselect all surfaces and click on "edit": 

A



B

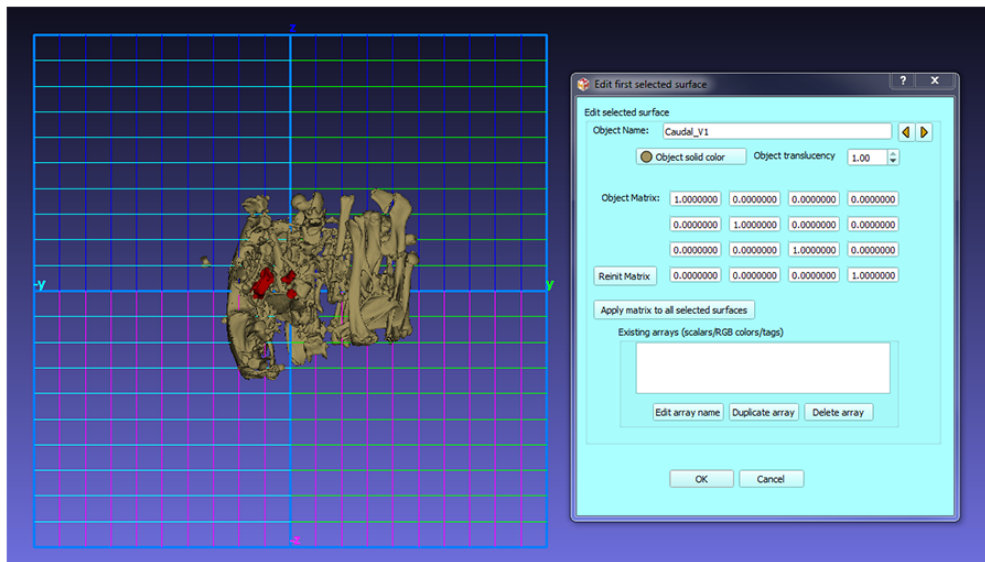




Figure 3.1: Opening many surfaces at once and changing their color. A: you may drag and drop all 74 surfaces surface at once inside the main 3D window. B: you may then browse through the 74 opened surfaces via the "Edit first selected surface" window and change the solid color of each bone.







this button opens the "Edit first selected surface" window (see Fig. 3.1-B p.4). Then click on  and  to navigate through all opened objects and to select them 1 by 1. That way, you can edit the properties of each of them individually.




- **Selecting surfaces with the mouse:** maintaining the right mouse button pressed while dragging the mouse will draw a selection rectangle. Once the right mouse button has been released, all unselected surfaces laying underneath the selection rectangle will be selected (and all selected surfaces will be unselected).

- **Selecting all surfaces:**

all opened surfaces can be selected by pressing "CTRL +A" (conversely, all surfaces can be unselected by pressing "CTRL +D")

In order to help positioning surfaces in a biologically-relevant manner, 6 predefined camera positions are defined:

-  view object from right side
-  view object from left side
-  view object from front side (default camera position)
-  view object from back side
-  view object from above
-  view object from below

In "object interaction mode()", selected objects can be translated and rotated using the mouse left and middle buttons (in landmark  and camera  selection modes, you also need to maintain "CTRL" button pressed while dragging the left mouse button to achieve rotation and translation of selected objects). Alternatively, you may also use the "yellow sliders" located on the right side of the 3D main window to accomplish rotation and translation of selected objects. Rotation is achieved around the global center of mass of all currently selected objects, which is convenient to rotate groups of bones (ex: all bones belonging a given anatomical unit such as the limbs, the head, the tail etc.) For instance, if you have managed to position the bones belonging to the right forelimb of *Canariomys bravori* in anatomical connection after displacing each bone one by one, in a second time, you may select all these bones and displace/rotate the whole forelimb in relation to the other parts of the reconstruction.

This tutorial contains two series of 74 .pos files. You may for instance change the position of a selected object by loading a .pos file (File -> Open Position -> Open Position for selected surfaces). For a given bone, you may choose any of the available .pos files, but this only makes sense to choose one of the two related to the currently selected bone. In this tutorial, the .pos files are named the following way: **Bone_name_initial_position**.pos or **Bone_name_anatomical_position**.pos.

3.2.3 Renaming surfaces

In some cases, you may need to change the name of some surfaces. For instance, you may disagree with our interpretation of which vertebra is the last thoracic one, and which is the first lumbar one. To change the name of one bone, select one (and only one) surface, click on "edit" to open the "Edit first selected surface" window (see Fig. 3.1-B p.4). Then change the "Object Name" field.

3.2.4 Projects: save/load the 74 bones and associated properties

Saving the project

Saving a "project" makes it possible to save all opened selected objects at once. In the preceding steps, you may have spent time to change the color and position of each of the 74 surface objects, and saving a "project" is the best way to save your work in a single step. To save all opened objects, do the following sequence of actions:

- 1) press "CTRL + A" to select all opened surfaces
- 2) click on "File->Project->Save Project" or on the button "save project" (📁) inside the main window.
- 3) chose the desired options in the "Save Project" window (see Fig. 3.2 p.7 and the User Guide for further details regarding the available options)

The advantage of working with projects is that all involved objects and their properties (surfaces, landmarks, positions etc.) can be reloaded later all at once (and not 1 by 1).

Opening projects

This tutorial contains 2 project (.ntw) files. To open one of them, first delete all opened objects (press "CTRL+A", then press "Del"). Then open one of the two available project files (File -> Project -> Open Project). Choose either "initial_position.ntw" or "anatomical_position.ntw". Once loaded, the 74 surface file objects are opened, are given a position and a color.

When opening "initial_position.ntw", each bone is given the position described in the file **Bone_name_initial_position**.pos.

When opening "anatomical_position.ntw", each bone is given the position contained in the file **Bone_name_anatomical_position**.pos. The color associated to each bone is defined in the chosen .ntw file. Note that all newly opened surfaces are unselected.

3.2.5 *Canariomys* .ori file

The present tutorial contains a .ori file, which contains orientation labels for the coordinate system orientation helper. You can load this file the enclosed .ori file ("File->Orientation helper labels -> Open Orientation labels", then select "Canariomys.ori"). Once loaded, the system coordinate orientation helper will show the following labels :

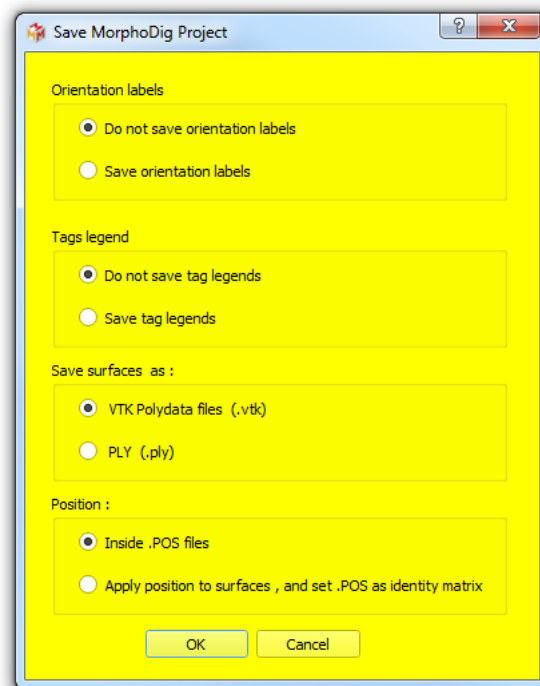


Figure 3.2: Save project window.

+z axis : dorsal
-z axis : ventral
+y axis : left
-y axis : right
+x axis : proximal
-x axis : distal

You may set your own orientation axis labels with the "Edit orientation labels" window (Edit-> Edit orientation labels)

3.2.6 Acknowledgements

I am grateful to María Esther Martín González, curator of the Museo de la Naturaleza y el Hombre, Santa Cruz, for her enthusiasm regarding the diffusion of the present tutorial. I thank Franck Guy (formerly IPHEP lab, now PALEVOPRIM), who performed the CT scan of TFMCV872, and the MRI imaging platform for the access to imaging facilities. The present reconstruction was initiated by Mikael Antocio during the academic year 2010–2011, at the Paleontology Department, University of Montpellier. Thanks to Lionel Hautier (ISEM) for his helpful expertise regarding mammalian vertebral anatomy.

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